CLAIMS

I claim:

1. A bi-directional stepping motor in which a rotor is rotatable in steps of 180 degrees each, the stepping motor comprising:

a rotor comprising a permanent magnet and rotatably mounted about an axis and providing a permanent magnetic field;

a first electrical coil and a second electrical coil;

a stator comprising:

three pole faces arranged around the rotor,

a first arm on which the first electrical coil is mounted; and

a second arm on which the second electrical coil is mounted;

a control circuit, coupled to the first and second electrical coils, for applying electrical pulses independently to each coil and for controlling the polarity thereof, the coils producing magnetic fields in response to the pulses and wherein the rotor is rotatable in response to the magnetic fields;

wherein each step of 180 degrees is effectuated by providing to the first coil, a first pulse of a first polarity and a second pulse of a second polarity; and to said second coil, a pulse of the second polarity simultaneously with the providing of the second pulse to the first coil;

wherein during the providing of the first pulse to the first coil, there is no pulse being provided to the second coil.

2. The stepping motor as claimed in claim 1, wherein the rotation of the second 180 degree step is achieved by providing:

to the first coil, a third pulse of the second polarity and a fourth pulse of the first polarity; and to said second coil, a pulse of the first polarity simultaneously with the providing of the fourth pulse to the first coil;

wherein during the providing the third pulse to the first coil, there is no pulse being provided to the second coil.

3. The bi-directional stepping motor as claimed in claim 1, wherein the three pole faces are arranged at an angular spacing of approximately 120 degrees with respect to each other.

4. A bi-directional stepping motor in which a rotor is rotatable by two steps of 180 degrees each, the stepping motor comprising:

a rotor comprising a permanent magnet and rotatably mounted about an axis and providing a permanent magnetic field;

a first electrical coil and a second electrical coil;

a stator comprising:

three pole faces arranged around the rotor,

a first arm on which the first electrical coil is mounted; and

a second arm on which the second electrical coil is mounted;

a control circuit, coupled to the first and second electrical coils, for applying electrical pulses independently to each coil and for controlling the polarity thereof, the coils producing magnetic fields in response to the pulses and wherein the rotor is rotatable in response to the magnetic fields;

wherein each step of 180 degrees is effectuated by a rotation of the rotor a first X degrees and then by a further rotation of the rotor the remaining 180-X degrees, wherein X is a predetermined number greater than zero;

wherein the rotation of the rotor the approximately X degrees is achieved by providing to the first coil, a first pulse of a first polarity; and

wherein the rotation of the rotor the approximately 180-X degrees to complete a step is achieved by providing to the first coil a second pulse of a second polarity simultaneously with the providing of a pulse of the second polarity to the second coil.

5. The bi-directional stepping motor as claimed in claim 4, wherein the second step of 180 degrees is effectuated by the additional rotation of the rotor X degrees and then by a further rotation of the rotor the remaining 180-X degrees;

wherein the additional rotation of the rotor X degrees is achieved by providing to the first coil, a third pulse of the second polarity; and

wherein the rotation of the rotor the approximately 180-X degrees to complete the second step is achieved by providing to the first coil a fourth pulse of the first polarity simultaneously with the providing of a pulse of the first polarity to the second coil;

whereby during the providing of the third pulse to the first coil, there is no pulse being provided to the second coil.

6. The bi-directional stepping motor as claimed in claim 4, wherein the value of X is approximately 30 degrees.

7. A bi-directional stepping motor in which a rotor rotates in steps of 180 degrees, the stepping motor comprising:

a rotor comprising a permanent magnet and rotatably mounted about an axis and providing a permanent magnetic field;

a first electrical coil and a second electrical coil;

a stator comprising:

three pole faces arranged around the rotor,

a first arm on which the first electrical coil is mounted; and

a second arm on which the second electrical coil is mounted;

a control circuit, coupled to the first and second electrical coils, for applying electrical pulses independently to each coil and for controlling the polarity thereof, the coils producing magnetic fields in response to the pulses and wherein the rotor is rotatable in response to the magnetic fields;

wherein each step of 180 degrees is effectuated by a rotation of the rotor a first X degrees and then by a further rotation of the rotor the remaining 180-X degrees, wherein X is a predetermined number greater than zero;

wherein a first pulse of a first polarity to the first coil creates a magnetic field sufficient to rotate the rotor approximately X degrees; and

wherein a second pulse of a second polarity to the first coil simultaneously with a pulse of the second polarity to the second coil creates a resultant magnetic field sufficient to rotate the rotor the approximately 180-X degrees to complete a step.

8. The bi-directional stepping motor as claimed in claim 7, wherein the value of X is approximately 30 degrees.

9. The stepping motor as claimed in claim 1, wherein the stepping motor is incorporated into a wristwatch.

10. A method of rotating a rotor in a stepping motor in steps of 180 degrees each, wherein the stepping motor comprises a rotor comprising a permanent magnet and rotatably mounted about an axis and providing a permanent magnetic field, a first electrical coil and a second electrical coil, a stator comprising three pole faces arranged around the rotor, a first arm on which the first electrical coil is mounted and a second arm on which the second electrical coil is mounted, and a control circuit, coupled to the first and second electrical coils, for applying electrical pulses independently to each coil and for controlling the polarity thereof, the coils producing magnetic fields in response to the pulses and wherein the rotor is rotatable in response to the magnetic fields, wherein each step of 180 degrees is effectuated by the steps of:

providing to the first coil, a first pulse of a first polarity and a second pulse of a second polarity; and to said second coil, a pulse of the second polarity simultaneously with the providing of the second pulse to the first coil;

wherein during the providing of the first pulse to the first coil, there is no pulse being provided to the second coil.

11. The method as claimed in claim 10, including the steps of providing:

to the first coil, a third pulse of the second polarity and a fourth pulse of the first polarity; and to said second coil, a pulse of the first polarity simultaneously with the providing of the fourth pulse to the first coil;

wherein during the providing the third pulse to the first coil, there is no pulse being provided to the second coil.

12. A method of rotating a rotor in a bi-directional stepping motor comprising a first electrical coil and a second electrical coil, a stator comprising three pole faces arranged around the rotor, a first arm on which the first electrical coil is mounted and a second arm on which the second electrical coil is mounted, and a control circuit, coupled to the first and second electrical coils, for applying electrical pulses independently to each coil, the method comprising the steps of:

applying electrical pulses independently to the first and second coils and controlling the polarity thereof, the coils producing magnetic fields in response to the pulses and wherein the rotor is rotatable in response to the magnetic fields;

rotating the rotor a first X degrees and then rotating the rotor an additional 180-X degrees, wherein X is a predetermined number greater than zero, wherein the rotation of the rotor the approximately X degrees is achieved by providing to the first coil, a first pulse of a first polarity; and

providing to the first coil a second pulse of a second polarity simultaneously with the providing of a pulse of the second polarity to the second coil for causing the rotation of the rotor the approximately 180-X degrees to complete a step.

13. The method as claimed in claim 12, including the steps of:

providing to the first coil, a third pulse of the second polarity for causing the rotor to rotate another X degrees; and

providing to the first coil a fourth pulse of the first polarity simultaneously with the providing of a pulse of the first polarity to the second coil for causing the rotation of the rotor the approximately 180-X degrees to complete the second step;

whereby during the providing of the third pulse to the first coil, there is no pulse being provided to the second coil.

14. The method as claimed in claim 12, wherein the value of X is approximately 30 degrees.

15. A timepiece comprising at least one stepping motor as claimed in claim 1.

16. A timepiece comprising at least one stepping motor as claimed in claim 4.

17. A timepiece comprising at least one stepping motor as claimed in claim 7.